P1.18 CLIMATE OF THE MOUNTAIN TOP STATION "SONNBLICK" IN COMPARISON WITH RADIOSONDE DATA

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1. INTRODUCTION

The mountain-observatory of Sonnblick (founded 1886) in the Austrian alps has one of the longest measurement time series of mountain-observatories all over the world. Therefore, the station is often used for climatological investigations. One important point in working with climatologically data is the knowledge of the data quality and homogeneity of the data. For testing the time series in respect to inhomogeneities, there exist several methods. One of these is the comparison with radio sounding data of a nearby sounding station, which was done recently by Richner and Phillips (1984). A new approach is to use an interpolation mode to compare the data of several sounding-stations and the measurements of the observatory at the same location. This leads to two conclusions: On the one hand, inhomogenities can be detected and on the other hand, the time series allows a statement about the differences between the climate on the mountain station in comparison with the climate of the free atmosphere.

2. THE INTERPOLATION METHOD 'VERA'

The interpolation mode used for the calculations is the Vienna Enhanced Resolution Analysis (VERA). It has been developed at the Institute of Meteorology in Vienna by Steinacker et. al (1999), based on the cubic spline method of Fritsch (1971).
A short explanation of the method shall be given here. The interpolation mode is searching for a smooth surface, which is a priori represented only at several points, given by the irregular distributed measurements of meteorological parameters.
This smooth surface can be found mathematically by minimizing the so-called cost function used in the variational analysis. The minimization assures that the curvature of the surface is as small as possible. The cost function is approximated with a taylor-series of expansion, using only the first and second derivations. For minimizing the function, at least ten stations with measurements must be given to enable the computation. Additional to this fact, the given points need to have a good geographical position to each other.

3. CONCLUSIONS

Several parameters were tested during the investigation. These are temperature, geopotential height, mixing ratio and, as the only vectorial variable, wind-direction.
For each of this parameters, the values of nearby radio soundings are measured for nearly each date, two times a day (00 UTC and 12 UTC) and they are quality-checked for gross errors within the project CALRAS. As the Sonnblick-observatory has an elevation of 3105 meters above sea level, the values are compared with the radio sounding data at the pressure-layer of 700 hPa. This is the first of two approximations. The second one emerges from the fact that the measurements at the observatory were taken at 07, 12 and 19 hours local time. For the comparison with the 00 UTC radio soundings, the average of the 19 and 07 hours measurement was calculated.
As it was mentioned in the chapter about VERA, the interpolation mode needs several radio sounding stations for interpolating the values for the coordinates of the Sonnblick-observatory. If the number of stations is too small, no interpolation is possible. If the geographical distribution of the stations is disadvantageous, the result of the interpolation may be less representative, which analytical tests showed.

3.1. Temperature

The investigations of temperature, which were made for the years 1974 to 1999, lead to the conclusion that the free atmosphere is warmer than the air at the mountain top. The root mean square for the differences is 2.35°C, the bias is +1°C. During the 25 years, the average temperature is –4.9°C for the Sonnblick measurements and –3.7°C for the radio soundings. Additionally there is a significant positive trend which leads to a warming of +1.46°C in 25 years. For the free atmosphere the temperature trend is only +1.28°C for the same time period.
For the differences between the interpolated values and the measured ones at the Sonnblick, there is a seasonal fluctuation which can be explained by the fact that the height of the 700hPa-pressure-level varies with the seasons. In winter, the 700hPa-level lies typically lower then the observatory.
The test of homogeneity for each of the parameters was calculated by summarizing the differences between interpolated value and measurement at the Sonnblick. For the temperature no significant breaks in homogeneity were found.

3.2. Geopotential height

The geopotential height is measured for the radiosondes, but usually not for the Sonnblick. Assuming that the atmosphere is polytropic, the Sonnblick values were reduced to the 700hPa-level and the geopotential height was calculated for each date. With this assumption, the values could be directly compared.

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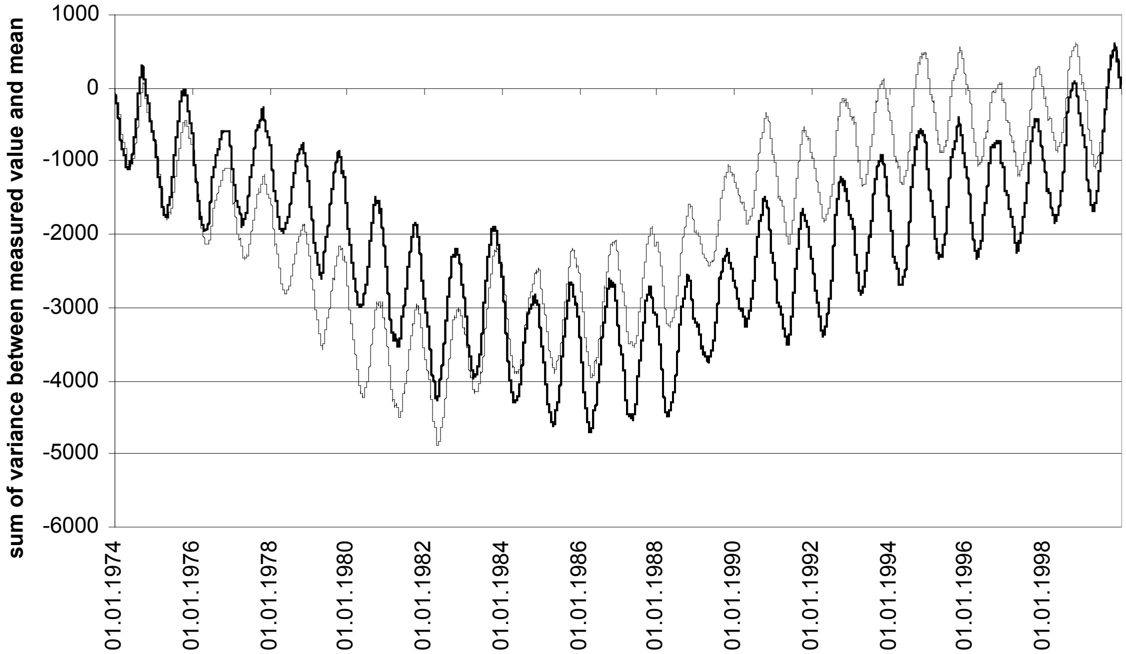

Fig.1: For each date, the difference between measured and mean value was calculated. The sum of this differences is plotted, the thick line is for the Sonnblick, the thin line for the interpolated values. Decreasing values represent cold, increasing values represent warm periods, on the average there is a warming for both series, but not with the same temporal evolution.

The root mean square of the differences is 15.7m and the bias is +4m, the investigation was made for the years 1974 to 1999. This means that the interpolated values are on the average higher than the measurements of the Sonnblick.
Testing the homogeneity, several breakpoints could be detected. As the temperature shows no inhomogeneities, these breakpoints have to be the result of changes in the measurement of pressure.

3.3. Mixing ratio

The mixing ratio for both the Sonnblick measurements and the radiosondes were calculated from relative humidity and temperature. The tested time series last from 1974 to 1990.
On the average, the mountain station has a mixing ratio 30 percent higher than the interpolated value from the radiosoundings, only in winter the results for interpolation and measurement are nearly equal. In addition, the mixing ratio for the interpolated values decrease in proportion to the Sonnblick measurements. The test of homogeneity showed no brakes for the 17 years investigated.

3.4. Wind direction

The time period for the investigation of the wind direction also lasts from 1974 to 1990. The wind direction was expected to be strongly affected by local effects, and for this reason, the direction was only investigated for the mean directions in 45° steps.
60 percent of the interpolated values coincide with the measurements of the Sonnblick, which is a remarkable high value, taking into account that most of the radiosondes are situated North or South of the Alps and not in mountainous regions itself. Nevertheless, the frequency of easterly winds is overestimated by the interpolation, while westerly winds are noticeable underestimated.
In the time series, one brake in the homogeneity was detected.

4. OUTLOOKS

Some of the results presented still have to be checked for their reasons which can be caused by physical processes or by problems in measurements.
Furthermore, the investigations should be done for even longer time series and other mountain-top stations to have more data for comparisons.

5. REFERENCES

Fritsch J.M., 1971: Objective Analysis of a Two Dimensional Data Field by the Cubic Spline Technique. *monthly weather review, Vol.99 No.5, pp.379-386*

Richner H. und Phillips P., 1984: A Comparison of Temperatures from Mountaintops and the free Atmosphere. *monthly weather review, Vol.112 , pp.1328-1339*

Steinacker R., Häberli C. und Pöttschacher W., 1999: A Transparent Method for the Analysis and Quality Evaluation of Irregularly Distributed and Noisy Observational Data. *monthly weather review, Vol.128, pp.2303-2316*

VERA:
http://www.univie.ac.at/IMG-Wien/vera

CALRAS:
http://www.univie.ac.at/~haeberc3/calras.htm